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Formation of optical bullets in laser-driven plasma bubble accelerators P. DONG, S.A. REED, S. YI, S. KALMYKOV, G. SHVETS, Physics Department, U. of Texas at Austin, N.H. MATLIS, W.P. LEEMANS, LBNL, C. MCGUFFEY, S.S. BULANOV, V. CHVYKOV, G. KALINTCHENKO, K. KRUSHELNIK, A. MAKSIMCHUK, T. MATSUOKA, A.G.R. THOMAS, V. YANOVSKY, CUOS, U. of Michigan — We show that luminal velocity electron density bubbles produced by relativistically intense ultrashort drive laser pulses propagating through near-atmospheric-density plasma re-shape co-propagating probe pulses into optical "bullets" that we reconstruct using frequency-domain interferometric techniques and use to visualize the spatio-temporal profile of the plasma bubble. A study of bubble-compressed bullets together with bubble-accelerated electrons reveals three regimes: (I) bullets of sub-plasma-wavelength (sub-λ_p) size, trapped and compressed inside plasma bubbles, appear at $1 < n_e < 1.5 \times 10^{19}$ cm^{-3} without production of relativistic electrons; (II) enlongated bullets spanning $\sim 2\ \lambda_p$, signifying temporary merging of sequential bubbles, are observed frequently at $n_e > 2 \times 10^{19}$ cm^{-3} together with poly-energetic relativistic electrons; (III) mono-energetic electrons are observed only in conjunction with intense sub-λ_p bullets signifying stable or contracted bubbles, generally at $n_e > 2.5 \times 10^{19}$ cm^{-3}. The results help to relate bubble structure to the properties of laser-wakefield-accelerated electrons in the blowout regime.

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